

WHAT IS CLAIMED IS:

1. A heat treatment apparatus comprising:  
a plurality of induction heating devices which  
heat a steel product;

5 a correctional device for correcting the steel  
product;

a computing device which computes supply  
predetermined electric power which is supplied to the  
induction heating devices, on the basis of a size of  
10 the steel product, a conveying speed of the steel  
product, heating target temperatures of the steel  
product, and a predetermined temperature of the steel  
product at the previous stage of the induction heating  
devices; and

15 a power supply unit which supplies the supply  
predetermined electric power computed by the computing  
device to the induction heating devices,

wherein the computing device computes supply  
predetermined electric power to be supplied to the  
20 induction heating devices in order to heat the steel  
product so that the steel product has a surface  
temperature equal to or lower than a first target  
temperature while being heated, and a difference  
between a second target temperature and a temperature  
25 which the steel product has at a predetermined position  
in the thickness direction of the steel product when  
the heating is completed falls within a predetermined

range, or so that the steel product has a surface equal to or higher than a third target temperature while being heated and has a temperature equal to or lower than a fourth target temperature at the predetermined  
5 portion in the thickness direction of the steel product when the heating is completed.

2. The heat treatment apparatus according to claim 1, wherein the induction heating devices are disposed on a rolling line of the steel product, and  
10 heat the steel product which was swiftly cooled by an accelerated cooling device after rolling.

3. The heat treatment apparatus according to claim 1, wherein the conveying speed of the steel product is a conveying speed determined in advance on  
15 the basis of the size of the steel product.

4. The heat treatment apparatus according to claim 1, wherein the computing device includes:

temperature estimating means for estimating a surface temperature of the steel product and an  
20 internal temperature in the thickness direction after induction heating on the basis of the data including the conveying speed of the steel product and the supply predetermined electric power;

fitting judging means for judging whether or not  
25 the surface temperature of the steel product and the internal temperature in the thickness direction are fit for predetermined temperature conditions;

judging processing means for correcting the supply  
predetermined electric power when they are not fit for  
the temperature conditions, and for repeatedly  
executing the temperature estimating means and the  
5 fitting judging means; and

electric power determining means for determining  
the supply predetermined electric power used for the  
computing as electric power which is supplied to the  
induction heating devices when they are fit for the  
10 temperature conditions.

5. The heat treatment apparatus according to  
claim 1, wherein the computing device includes:

temperature estimating means for estimating  
a surface temperature of the steel product and an  
15 internal temperature in the thickness direction after  
induction heating on the basis of the data including  
the conveying speed of the steel product and the supply  
predetermined electric power;

fitting judging means for judging whether or not  
20 the surface temperature of the steel product and the  
internal temperature in the thickness direction are fit  
for predetermined temperature conditions;

judging processing means for correcting the supply  
predetermined electric power when they are not fit for  
25 the temperature conditions, and for repeatedly  
executing the temperature estimating means and the  
fitting judging means;

electric energy judging means for judging whether  
or not a total value of electric energy of the  
respective induction heating devices used for the  
heating of the steel product is fit for the electric  
5 power condition which is less than or equal to a  
predetermined value, on the basis of the supply  
predetermined electric power used for the computing  
when they are fit for the temperature conditions; and

electric power determining means for determining  
10 the supply predetermined electric power used for the  
computing as electric power which is supplied to the  
induction heating devices when they are fit for the  
temperature conditions.

6. The heat treatment apparatus according to  
15 claim 1, wherein the computing device includes:

temperature estimating means for estimating  
a surface temperature of the steel product and  
an internal temperature in the thickness direction  
after induction heating on the basis of the data  
20 including the conveying speed of the steel product and  
the supply predetermined electric power;

fitting judging means for judging whether or not  
the surface temperature of the steel product and the  
internal temperature in the thickness direction are fit  
25 for predetermined temperature conditions; and

electric power determining means for determining  
supply predetermined electric power in which a total

value of the electric energy of the respective  
induction heating devices used for the heating of the  
steel product becomes a minimum, among the supply  
predetermined electric powers which are fit for the  
5 temperature conditions, as electric power which is  
supplied to the induction heating devices.

7. The heat treatment apparatus according to  
claim 1, wherein the computing device further includes  
temperature distribution estimating means for  
10 estimating a temperature distribution in the thickness  
direction of the steel product after being heated by  
the induction heating devices.

8. The heat treatment apparatus according to  
claim 7, wherein the temperature distribution  
15 estimating means includes:

generated heat amount calculating means for  
obtaining an induced current distribution in the  
thickness direction of the steel product present in the  
induction heating devices, in accordance with a speed  
20 at which the steel product is being transported, and  
for calculating an amount of heat generated in the  
steel product.

radiated heat amount calculating means for  
calculating a radiated heat amount from the steel  
25 product to the atmosphere at the outside of the  
induction heating devices; and

temperature computing means for estimating

a surface temperature of the steel product and  
an internal temperature in the thickness direction due  
to a heat conduction to the inside of the steel product  
being computed with the generated heat amount and  
5 the radiated heat amount serving as the boundary  
conditions.

9. The heat treatment apparatus according to  
claim 7, wherein

the temperature distribution estimating means  
10 includes cooling temperature estimating means for  
estimating a temperature falling amount in the  
thickness direction of the steel product by  
a correctional device.

10. The heat treatment apparatus according to  
15 claim 1, wherein the computing device further includes

heating history managing means for imaginarily  
dividing into a plurality of sections in the  
longitudinal direction of the steel product, and for  
managing the history, in unit of the section, of the  
20 heating electric power used for the heating of the  
steel product and the temperature detected value of  
the steel product.

11. The heat treatment apparatus according to  
claim 1, wherein the computing device includes:

25 temperature estimating means for estimating  
a surface temperature of the steel product and  
an internal temperature in the thickness direction

after induction heating on the basis of the data including the conveying speed of the steel product and the supply predetermined electric power;

fitting judging means for judging whether or not  
5 the surface temperature of the steel product and the internal temperature in the thickness direction are fit for predetermined temperature conditions; and

electric power determining means for determining supply predetermined electric power in which the  
10 conveying speed of the steel product becomes a maximum, among the supply predetermined electric powers which are fit for the temperature conditions, as electric power which is supplied to the induction heating devices.

15 12. The heat treatment apparatus according to claim 1, wherein the computing device includes:

temperature estimating means for estimating a surface temperature of the steel product and an internal temperature in the thickness direction  
20 after induction heating on the basis of the data including the conveying speed of the steel product and the supply predetermined electric power;

fitting judging means for judging whether or not the surface temperature of the steel product and the  
25 internal temperature in the thickness direction are fit for predetermined temperature conditions;

judging processing means for correcting the supply

predetermined electric power when they are not fit for the temperature conditions, and for repeatedly executing the temperature estimating means and the fitting judging means;

5           electric power judging means for judging whether or not a total value of electric energy of the respective induction heating devices used for the heating of the steel product is fit for the electric power condition which is less than or equal to  
10       a predetermined value, on the basis of the supply predetermined electric power used for the computing when they are fit for the temperature conditions; and  
          conveying speed computing means for repeatedly executing the temperature estimating means, the fitting  
15       judging means, the judging processing means, and the electric power judging means, until it is not fit for the temperature conditions, by using a new conveying speed in which the conveying speed is increased when they are fit for the temperature conditions, and for  
20       acquiring the conveying speed which is fit for the temperature condition and the electric power condition and which was used for the final computing, as the new conveying speed.

13. A heat treatment apparatus comprising:

25           a plurality of induction heating devices which are disposed on a rolling line of a steel product, and which are arranged at the rear stage of an accelerated



cooling device swiftly cooling the rolled steel product;

a correctional device which corrects the steel product;

5           at least one temperature detector which is disposed on the rolling line and which detects a temperature of the steel product;

          a computing device which computes supply predetermined electric power which is supplied to  
10   the induction heating devices, on the basis of a size of the steel product, a conveying speed of the steel product, a heating target temperature of the steel product, and an actually measured temperature of the steel product measured by the temperature  
15   detector at the previous stage of the induction heating devices; and

          a power supply unit which supplies the supply predetermined electric power computed by the computing device to the induction heating devices,

20           wherein the computing device computes supply predetermined electric power to be supplied to the induction heating devices in order to heat the steel product so that the steel product has a surface temperature equal to or lower than a first target  
25   temperature while being heated, and a difference between a second target temperature and a temperature which the steel product has at a predetermined position

in the thickness direction of the steel product when the heating is completed falls within a predetermined range, or so that the steel product has a surface equal to or higher than a third target temperature while  
5 being heated and has a temperature equal to or lower than a fourth target temperature at the predetermined position in the thickness direction of the steel product when the heating is completed.

14. The heat treatment apparatus according to  
10 claim 13, wherein the computing device includes:

estimating means for estimating a steel product temperature after being heated on the basis of the conveying speed and the steel product temperature which was measured by the temperature detector;

15 repeating means for changing the conveying speed when the estimated steel product temperature is not within a predetermined temperature range, and for repeatedly executing the estimating means; and

electric power computing means for computing  
20 supply predetermined electric power which is supplied to the induction heating devices in order to heat the steel product to a target temperature on the basis of the conveying speed when the estimated steel product temperature is within the predetermined temperature  
25 range.

15. The heat treatment apparatus according to claim 13, wherein the computing device includes:

temperature estimating means for estimating  
a surface temperature of the steel product and  
an internal temperature in the thickness direction  
after induction heating on the basis of the data  
5 including the conveying speed of the steel product and  
the supply predetermined electric power;

fitting judging means for judging whether or not  
the surface temperature of the steel product and the  
internal temperature in the thickness direction are fit  
10 for predetermined temperature conditions;

judging processing means for correcting the supply  
predetermined electric power when they are not fit for  
the temperature conditions, and for repeatedly  
executing the temperature estimating means and the  
15 fitting judging means; and

electric power determining means for determining  
the supply predetermined electric power used for the  
computing as electric power which is supplied to the  
induction heating devices when they are fit for the  
20 temperature conditions.

16. The heat treatment apparatus according to  
claim 13, wherein the computing device includes:

temperature estimating means for estimating  
a surface temperature of the steel product and  
25 an internal temperature in the thickness direction  
after induction heating on the basis of the data  
including the conveying speed of the steel product and

the supply predetermined electric power;

fitting judging means for judging whether or not  
the surface temperature of the steel product and the  
internal temperature in the thickness direction are fit  
5 for predetermined temperature conditions;

judging processing means for correcting the supply  
predetermined electric power when they are not fit for  
the temperature conditions, and for repeatedly  
executing the temperature estimating means and the  
10 fitting judging means;

electric energy judging means for judging whether  
or not a total value of electric energy of the  
respective induction heating devices used for the  
heating of the steel product is fit for the electric  
15 power condition which is less than or equal to  
a predetermined value, on the basis of the supply  
predetermined electric power used for the computing  
when they are fit for the temperature conditions; and

electric power determining means for determining  
20 the supply predetermined electric power used for the  
computing as electric power which is supplied to the  
induction heating devices when they are fit for the  
temperature conditions.

17. The heat treatment apparatus according to  
25 claim 13, wherein the computing device includes:

temperature estimating means for estimating  
a surface temperature of the steel product and

an internal temperature in the thickness direction after induction heating on the basis of the data including the conveying speed of the steel product and the supply predetermined electric power;

5           fitting judging means for judging whether or not the surface temperature of the steel product and the internal temperature in the thickness direction are fit for predetermined temperature conditions; and

          electric power determining means for determining  
10       supply predetermined electric power in which a total value of the electric energy of the respective induction heating devices used for the heating of the steel product becomes a minimum, among the supply predetermined electric powers which are fit for the  
15       temperature conditions, as electric power which is supplied to the induction heating devices.

          18. The heat treatment apparatus according to claim 13, wherein the computing device further includes  
          temperature distribution estimating means for  
20       estimating a temperature distribution in the thickness direction of the steel product after being heated by the induction heating devices.

          19. The heat treatment apparatus according to claim 18, wherein the temperature distribution  
25       estimating means includes:

          generated heat amount calculating means for obtaining an induced current distribution in

the thickness direction of the steel product present in the induction heating devices, in accordance with a speed at which the steel product is being transported, and for calculating an amount of heat generated in the steel product.

radiated heat amount calculating means for calculating a radiated heat amount from the steel product to the atmosphere at the outside of the induction heating devices; and

temperature computing means for estimating a surface temperature of the steel product and an internal temperature in the thickness direction due to a heat conduction to the inside of the steel product being computed, with the generated heat amount and the radiated heat amount serving as the boundary conditions.

20. The heat treatment apparatus according to claim 18, wherein the temperature distribution estimating means includes cooling temperature estimating means for estimating a temperature falling amount in the thickness direction of the steel product by a correctional device.

21. The heat treatment apparatus according to claim 13, wherein the computing device further includes heating history managing means for imaginarily dividing into a plurality of sections in the longitudinal direction of the steel product, and for

managing the history, in unit of the section, of the heating electric power used for the heating of the steel product and the temperature detected value of the steel product.

5           22. The heat treatment apparatus according to claim 21 comprising:

target temperature calculating means for calculating heating target temperatures for each induction heating device with respect to the head  
10           portion and the back end portion of the steel product on the basis of a temperature of the head portion and a temperature of the back end portion of the steel product which were detected by the temperature detector provided at the entrance side of the induction heating  
15           device at the first stage, and the conveying speed of the steel product;

electric power supplying means for calculating electric power supplied to each induction heating device on the basis of the heating target temperatures  
20           at the head portion and the back end portion of the steel product, and for controlling the electric power in accordance with the movements of the head portion and the back end portion of the steel product and supplying it to the power supply unit;

25           intermediate portion target temperature calculating means, at the intermediate portion sandwiched by the head portion and the back end portion

of the steel product, on the basis of an actually measured temperature at the head portion of the steel product, an actually measured temperature at the back end portion, and an actually measured temperature at the intermediate portion, for correcting the heating target temperatures for each induction heating device at the head portion and the back end portion of the steel product, and for calculating the heating target temperatures for each induction heating device at the intermediate portion; and

intermediate electric power controlling means for calculating intermediate electric power supplied to each induction heating device on the basis of the heating target temperature of each induction heating device at the intermediate portion, and for controlling the intermediate electric power in accordance with the movement of the intermediate portion of the steel product and supplying it to the power supply unit.

23. The heat treatment apparatus according to claim 13 which includes the temperature detectors before and behind at least one of the induction heating devices, wherein

the computing device includes:

heating efficiency estimating means for estimating a heating efficiency of the induction heating devices on the basis of the electric power supplied to the induction heating devices and the rose temperature of



the steel product which was measured by the temperature detector; and

correction computing means for correction-computing the electric power determined with respect to the steel product for which a heat treatment is planned  
5 next time by using the heating efficiency.

24. The heat treatment apparatus according to claim 13, wherein the computing device includes:

temperature falling amount correcting means for  
10 correcting the radiated heat amount to the atmosphere from the steel product on the rolling line by an actual measured temperature; and

cooling correction electric power computing means for computing supply predetermined electric power for  
15 heating the steel product to a target temperature on the basis of the temperature falling amount estimated by the corrected radiated heat amount, with respect to the steel product for which a heat treatment is planned next time.

20 25. The heat treatment apparatus according to claim 13, wherein the computing device includes:

temperature falling amount correcting means for correcting the temperature falling amount by the correctional device of the steel product on the rolling  
25 line, by the actual measured temperature measured by the temperature detectors disposed before and behind the correctional device; and

cooling correction electric power computing means  
for computing supply predetermined electric power for  
heating the steel product to a target temperature on  
the basis of the corrected temperature falling amount  
5 at the correctional device, with respect to the steel  
product for which a heat treatment is planned next  
time.

26. The heat treatment apparatus according to  
claim 13 which includes at least one of the temperature  
10 detectors between the induction heating devices,  
further comprising:

feedback control means for controlling electric  
power which is supplied to the induction heating device  
at the previous stage on the basis of a difference  
15 between the steel product temperature measured by the  
temperature detector and the target temperature at the  
position which was provided in advance; and

feedforward control means for controlling electric  
power which is supplied to the induction heating device  
20 at the rear stage on the basis of a difference between  
the steel product temperature measured by the  
temperature detector and the target temperature at  
the position which was provided in advance.

27. The heat treatment apparatus according to  
25 claim 26, wherein the feedback control means controls  
electric power supplied to the induction heating device  
at the previous stage on the basis of a difference

between the steel product temperature measured by the temperature detector and the target temperature at the position which is provided in advance, in units of the plurality of sections which were imaginarily divided in the longitudinal direction of the steel product.

28. The heat treatment apparatus according to claim 26, wherein the feedforward control means controls heating electric power supplied to the induction heating device at the rear stage on the basis of a difference between the steel product temperature measured by the temperature detector and the target temperature at the position which is provided in advance, in units of the plurality of sections which were imaginarily divided in the longitudinal direction of the steel product.

29. A heat treatment apparatus comprising:  
a plurality of induction heating devices which are disposed on a rolling line of a steel product, and which are arranged at the rear stage of an accelerated cooling device swiftly cooling the rolled steel product;

a correctional device which corrects correcting the steel product;

at least one temperature detector which is disposed on the rolling line and which detects a temperature of the steel product;

a first computing device which computes first

supply predetermined electric power which is supplied to the induction heating devices, on the basis of a size of the steel product, a conveying speed of the steel product, a heating target temperature of the steel product, and a predetermined temperature of the steel product at the previous stage of the induction heating devices;

a second computing device which computes second supply predetermined electric power which is supplied to the induction heating devices, on the basis of the size of the steel product, a conveying speed of the steel product, a heating target temperature of the steel product, and an actually measured temperature of the steel product measured by the temperature detector at the previous stage of the induction heating devices;

an electric power selecting device which selects the first supply predetermined electric power as supply predetermined electric power when a difference between the predetermined temperature of the steel product and the actual measured temperature of the steel product is within a predetermined range, and which selects the second supply predetermined electric power as supply predetermined electric power when a difference between the predetermined temperature of the steel product and the actual measured temperature of the steel product is not within a predetermined range; and

a power supply unit which supplies the supply

predetermined electric power selected by the electric power selecting device to the induction heating devices,

5        wherein the first and the second computing devices compute supply predetermined electric power to be supplied to the induction heating devices in order to heat the steel product so that the steel product has a surface temperature equal to or lower than a first target temperature while being heated, and a difference  
10       between a second target temperature and a temperature which the steel product has at a predetermined position in the thickness direction of the steel product when the heating is completed falls within a predetermined range, or so that the steel product has a surface equal  
15       to or higher than a third target temperature while being heated and has a temperature equal to or lower than a fourth target temperature at the predetermined position in the thickness direction of the steel product when the heating is completed.

20       30. A heat treatment method of a heat treatment apparatus which includes a plurality of induction heating devices which heat a steel product, a correctional device for correcting the steel product, a computing device which computes supply predetermined  
25       electric power which is supplied to the induction heating device, and a power supply unit which supplies the supply predetermined electric power computed by the

computing devices to the induction heating device,  
comprising:

on the basis of a size of the steel product, a  
conveying speed of the steel product, heating target  
5 temperatures of the steel product, a predetermined  
temperature of the steel product at the previous stage  
of the induction heating device,

a step of computing supply predetermined electric  
power to be supplied to the induction heating devices  
10 in order to heat the steel product so that the steel  
product has a surface temperature equal to or lower  
than a first target temperature while being heated, and  
a difference between a second target temperature and a  
temperature which the steel product has at a  
15 predetermined position in the thickness direction of  
the steel product when the heating is completed falls  
within a predetermined range; or

a step of computing supply predetermined electric  
power to be supplied to the induction heating devices  
20 in order to heat the steel product so that the steel  
product has a surface equal to or higher than a third  
target temperature while being heated and has a  
temperature equal to or lower than a fourth target  
temperature at the predetermined position in the  
25 thickness direction of the steel product when the  
heating is completed.

31. The heat treatment method according to

claim 30, wherein the induction heating devices are disposed on a rolling line of the steel product, and heat the steel product which was swiftly cooled by an accelerated cooling device after rolling.

5           32. The heat treatment method according to claim 30, wherein

the conveying speed of the steel product is a conveying speed determined in advance on the basis of the size of the steel product.

10           33. The heat treatment method according to claim 30 further comprising:

a temperature estimating step of estimating a surface temperature of the steel product and an internal temperature in the thickness direction after  
15 induction heating on the basis of the data including the conveying speed of the steel product and the supply predetermined electric power;

a fitting judging step of judging whether or not the surface temperature of the steel product and the  
20 internal temperature in the thickness direction are fit for predetermined temperature conditions;

a judging processing step of correcting the supply predetermined electric power when they are not fit for the temperature conditions, and of repeatedly executing  
25 the temperature estimating means and the fitting judging means; and

an electric power determining step of determining

the supply predetermined electric power used for the computing as electric power which is supplied to the induction heating devices when they are fit for the temperature conditions.

5           34. A heat treatment method of a heat treatment apparatus which includes a plurality of induction heating devices which are disposed on a rolling line of a steel product, and which are arranged at the rear stage of an accelerated cooling device swiftly cooling  
10 the rolled steel product, a correctional device which corrects the steel product, at least one temperature detector which is disposed on the rolling line and which detects a temperature of the steel product, a computing device which computes supply predetermined  
15 electric power which is supplied to the induction heating device, and a power supply unit which supplies the supply predetermined electric power computed by the computing device to the induction heating devices, comprising:

20           on the basis of a size of the steel product, a conveying speed of the steel product, a heating target temperature of the steel product, and an actually measured temperature of the steel product measured by the temperature detector at the previous stage of the  
25 induction heating devices,

          a step of computing supply predetermined electric power to be supplied to the induction heating devices



in order to heat the steel product so that the steel product has a surface temperature equal to or lower than a first target temperature while being heated, and a difference between a second target temperature and a temperature which the steel product has at a predetermined position in the thickness direction of the steel product when the heating is completed falls within a predetermined range; or

a step of computing supply predetermined electric power to be supplied to the induction heating devices in order to heat the steel product so that the steel product has a surface equal to or higher than a third target temperature while being heated and has a temperature equal to or lower than a fourth target temperature at the predetermined position in the thickness direction of the steel product when the heating is completed.

35. The heat treatment method according to claim 34 further comprising:

an estimating step of estimating a steel product temperature after being heated on the basis of the conveying speed and the steel product temperature which was measured by the temperature detector;

a repeating step of changing the conveying speed, and of repeatedly executing the estimating means when the estimated steel product temperature is not within a predetermined temperature range; and

an electric power computing step of computing supply predetermined electric power which is supplied to the induction heating devices in order to heat the steel product to a target temperature on the basis of the conveying speed when the estimated steel product temperature is within the predetermined temperature range.

36. A heat treatment method of a heat treatment apparatus which includes a plurality of induction heating devices which are disposed on a rolling line of a steel product, and which are arranged at the rear stage of an accelerated cooling device swiftly cooling the rolled steel product, a correctional device which corrects the steel product, at least one temperature detector which is disposed on the rolling line and which detects a temperature of the steel product, a computing device which computes supply predetermined electric power which is supplied to the induction heating devices, and a power supply unit which supplies the computed supply predetermined electric power to the induction heating devices, comprising:

a supply predetermined electric power computing step of computing supply predetermined electric power to be supplied to the induction heating devices in order to heat the steel product so that the steel product has a surface temperature equal to or lower than a first target temperature while being heated,

and a difference between a second target temperature and a temperature which the steel product has at a predetermined position in the thickness direction of the steel product when the heating is completed falls within a predetermined range; or

5 a supply predetermined electric power computing step of computing supply predetermined electric power to be supplied to the induction heating devices in order to heat the steel product so that the steel product has a surface equal to or higher than a third target temperature while being heated and has a temperature equal to or lower than a fourth target temperature at the predetermined position in the thickness direction of the steel product when the heating is completed;

10 a step of executing the supply predetermined electric power computing step on the basis of a size of the steel product, a conveying speed of the steel product, a heating target temperature of the steel product, a predetermined temperature of the steel product at the previous stage of the induction heating devices when a difference between the predetermined temperature of the steel product and the actual measured temperature of the steel product is within a predetermined range; and

25 a step of executing the supply predetermined electric power computing step on the basis of the size

of the steel product, a conveying speed of the steel product, a heating target temperature of the steel product, and an actually measured temperature of the steel product measured by the temperature detector at  
5 the previous stage of the induction heating devices when a difference between the predetermined temperature of the steel product and the actual measured temperature of the steel product is not within a predetermined range.

10 37. A recording medium on which a heat treatment program is recorded, of a heat treatment apparatus which includes a plurality of induction heating devices which heat a steel product, a correctional device which corrects the steel product, a computing device which  
15 computes supply predetermined electric power which is supplied to the induction heating device, and a power supply unit which supplies the supply predetermined electric power computed by the computing device to the induction heating devices,

20 the recording medium recording a program thereon for making a computer execute,

on the basis of a size of the steel product, a conveying speed of the steel product, a heating target temperature of the steel product, a predetermined  
25 temperature of the steel product at the previous stage of the induction heating devices,

a step of computing supply predetermined electric

power to be supplied to the induction heating devices  
in order to heat the steel product so that the steel  
product has a surface temperature equal to or lower  
than a first target temperature while being heated,  
5 and a difference between a second target temperature  
and a temperature which the steel product has at  
a predetermined position in the thickness direction of  
the steel product when the heating is completed falls  
within a predetermined range; or

10 a step of computing supply predetermined electric  
power to be supplied to the induction heating devices  
in order to heat the steel product so that the steel  
product has a surface equal to or higher than a third  
target temperature while being heated and has a  
15 temperature equal to or lower than a fourth target  
temperature at the predetermined position in the  
thickness direction of the steel product when the  
heating is completed.

20 38. The recording medium according to claim 37,  
wherein

the induction heating devices are disposed on a  
rolling line of the steel product, and heat the steel  
product which was swiftly cooled by an accelerated  
cooling device after the rolling.

25 39. The recording medium according to claim 37,  
wherein

the conveying speed of the steel product is

a conveying speed determined in advance on the basis of the size of the steel product.

40. The recording medium according to claim 37 recording a program thereon for making a computer  
5 further execute,

a temperature estimating step of estimating  
a surface temperature of the steel product and  
an internal temperature in the thickness direction  
after induction heating on the basis of the data  
10 including the conveying speed of the steel product and  
the supply predetermined electric power;

a fitting judging step of judging whether or not  
the surface temperature of the steel product and the  
internal temperature in the thickness direction are fit  
15 for predetermined temperature conditions;

a judging processing step of correcting the supply  
predetermined electric power when they are not fit for  
the temperature conditions, and of repeatedly executing  
the temperature estimating means and the fitting  
20 judging means; and

an electric power determining step of determining  
the supply predetermined electric power used for the  
computing as electric power which is supplied to the  
induction heating devices when they are fit for the  
25 temperature conditions.

41. A recording medium on which a heat treatment  
program is recorded, of a heat treatment apparatus

which includes a plurality of induction heating devices which are disposed on a rolling line of a steel product, and which are arranged at the rear stage of an accelerated cooling device swiftly cooling the rolled steel product, a correctional device which corrects the steel product, at least one temperature detector which is disposed on the rolling line and which detects a temperature of the steel product, a computing device which computes supply predetermined electric power which is supplied to the induction heating device, and a power supply unit which supplies the supply predetermined electric power computed by the computing device to the induction heating devices,

the recording medium recording a program thereon for making a computer execute,

on the basis of a size of the steel product, a conveying speed of the steel product, a heating target temperature of the steel product, and an actually measured temperature of the steel product measured by the temperature detector at the previous stage of the induction heating devices,

a step of computing supply predetermined electric power to be supplied to the induction heating devices in order to heat the steel product so that the steel product has a surface temperature equal to or lower than a first target temperature while being heated, and a difference between a second target temperature

and a temperature which the steel product has at a predetermined position in the thickness direction of the steel product when the heating is completed falls within a predetermined range; or

5           a step of computing supply predetermined electric power to be supplied to the induction heating devices in order to heat the steel product so that the steel product has a surface equal to or higher than a third target temperature while being heated and has a  
10           temperature equal to or lower than a fourth target temperature at the predetermined position in the thickness direction of the steel product when the heating is completed.

42. The recording medium according to claim 41  
15           further recording a program thereon for making a computer execute:

          an estimating step of estimating a steel product temperature after being heated on the basis of the conveying speed and the steel product temperature which  
20           was measured by the temperature detector;

          a repeating step of changing the conveying speed when the estimated steel product temperature is not within a predetermined temperature range, and for repeatedly executing the estimating means; and

25           an electric power computing step of computing supply predetermined electric power which is supplied to the induction heating devices in order to heat the



steel product to a target temperature on the basis of the conveying speed when the estimated steel product temperature is within the predetermined temperature range.

5           43. A recording medium on which a heat treatment program is recorded, of a heat treatment apparatus which includes a plurality of induction heating devices which are disposed on a rolling line of a steel product, and which are arranged at the rear stage of an  
10 accelerated cooling device swiftly cooling the rolled steel product, a correctional device which corrects the steel product, at least one temperature detector which is disposed on the rolling line and which detects a temperature of the steel product, a computing device  
15 which computes supply predetermined electric power which is supplied to the induction heating devices, and a power supply unit which supplies the computed supply predetermined electric power to the induction heating devices,

20           the recording medium recording a program thereon for making a computer execute:

          a supply predetermined electric power computing step of computing supply predetermined electric power to be supplied to the induction heating devices in  
25 order to heat the steel product so that the steel product has a surface temperature equal to or lower than a first target temperature while being heated, and

a difference between a second target temperature and a temperature which the steel product has at a predetermined position in the thickness direction of the steel product when the heating is completed falls within a predetermined range; or

5 a supply predetermined electric power computing step of computing supply predetermined electric power to be supplied to the induction heating devices in order to heat the steel product so that the steel product has a surface equal to or higher than a third target temperature while being heated and has a temperature equal to or lower than a fourth target temperature at the predetermined position in the thickness direction of the steel product when the heating is completed;

10 a step of executing the supply predetermined electric power computing step on the basis of a size of the steel product, a conveying speed of the steel product, a heating target temperature of the steel product, a predetermined temperature of the steel product at the previous stage of the induction heating devices when a difference between the predetermined temperature of the steel product and the actual measured temperature of the steel product is within a predetermined range; and

25 a step of executing the supply predetermined electric power computing step on the basis of the size

of the steel product, a conveying speed of the steel product, a heating target temperature of the steel product, and an actually measured temperature of the steel product measured by the temperature detector at the previous stage of the induction heating devices when a difference between the predetermined temperature of the steel product and the actual measured temperature of the steel product is not within a predetermined range.

10           44. A steel product, wherein  
            the steel product is heat-treated by the heat treatment method according to claim 30.

            45. A steel product, wherein  
            the steel product is heat-treated by the heat treatment method according to claim 31.

15           46. A steel product, wherein  
            the steel product is heat-treated by the heat treatment method according to claim 32.

            47. A steel product, wherein  
20           the steel product is heat-treated by the heat treatment method according to claim 33.

            48. A steel product, wherein  
            the steel product is heat-treated by the heat treatment method according to claim 34.

25           49. A steel product, wherein  
            the steel product is heat-treated by the heat treatment method according to claim 35.

50. A steel product, wherein  
the steel product is heat-treated by the heat  
treatment method according to claim 36.